

On the 13th, 14th, and 15th high easterly winds of a local character occurred on the Strait of Juan de Fuca, for which timely warnings were issued during the afternoon of the 12th. Warnings were also issued on other dates, and they were generally verified, although the justifying velocities were not greatly exceeded.—*Edward A. Beals, District Forecaster.*

#### SOUTH PACIFIC FORECAST DISTRICT.

The month as a whole was one of good rainfall and moderate temperatures. There were but few severe storms and no serious frosts. From an agricultural standpoint the month was all that could be desired, although in portions of the Sacramento Valley heavy rains resulted in broken levees and the overflowing of much grain land.

During the first decade the depressions apparent on the north Pacific coast moved northeastward, and this as a rule means pleasant weather in California. On January 9 a disturbance moved in over southern California. This was anticipated in the forecasts. This disturbance followed an easterly course and played an important part in connection with the great high of January 12. A depression of some depth appeared on the Washington coast on January 13 and marked a distinct change in pressure distribution. Somewhat similar types followed during the remainder of the month.—*Alexander G. McAdie, Professor and District Forecaster.*

#### RIVERS AND FLOODS.

Owing to the continued cold weather of January there was no material change in the ice situation, except a gradual increase in the thickness of the ice and an extension of its southern limit into middle and northern Virginia and the upper Tennessee watershed. At the end of the month there were 30 inches of ice at Moorhead, Minn., on the Red River of the North; 22 inches at St. Paul and 11 inches at St. Louis on the Mississippi River; and 24, 14, and 10 inches, respectively, at Bismarck, N. Dak., Omaha, Nebr., and Kansas City, Mo., on the Missouri River; there were also 3 inches of ice on the upper French Broad River at Asheville, N. C., and the river

was frozen over at Dandridge, Tenn., for the first time in five years. There was a heavy gorge in the Mississippi River back of Cairo, Ill., and heavy ice from the lower Ohio was passing Memphis, Tenn.

There were no floods of any considerable magnitude east of the Rocky Mountains, although the heavy rains of the 11th and 12th in the South caused a decided rise in the rivers of Alabama. Warnings that were issued at the proper time were remarkably accurate, and were the means of saving a large amount of property, especially lumber. While the stages reached did not exceed the danger line except in the Tombigbee basin, yet the long duration of the low-water season made the warnings of unusual benefit and importance.

The warm rains from the 20th to the 22d in northern California extended well up into the snow regions of the Sacramento watershed, and as a result the accumulated snow of the winter was melted and carried down into the Sacramento River. Warnings of the flood were issued on the 22d, and the people in the threatened districts in Glenn and Colusa counties made all preparations possible. In Colusa County, however, weak levees were broken, while the waters washed over others, destroying 25,000 acres of growing grain, practically all of this year's crop. At Red Bluff the highest stage reached was 24.5 feet, 1.5 feet above the danger line, while at Colusa it was 28.3 feet, 3.3 feet above the danger line, 0.2 of a foot above any previous record.

The Columbia River was unusually low, and steamboat traffic was absolutely suspended above the mouth of the Wenatchee River.

The highest and lowest water, mean stage, and monthly range at 268 river stations are given in Table VII. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor.*

#### CLIMATE AND CROP SERVICE.

By Mr. JAMES BERRY, Chief of Climate and Crop Division.

The following summaries relating to the general weather and crop conditions during January are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau; they are based upon voluntary reports from meteorological observers and crop correspondents, of whom there are about 3300 and 14,000, respectively:

**Alabama.**—Cold, wet, and unfavorable for farm work. Excessive rains of 11th and 12th washed lands badly in many localities and caused rivers to overflow lowlands. Very little more wheat and oats were sown; the fall sown was damaged by severe freeze during middle of last decade, when temperature was as low as 17° to the Gulf coast. Fruit trees and strawberry plants continued in good condition. Very little truck land was prepared.—*F. P. Chaffee.*

**Arizona.**—The month was warm and wet. Snowfall in mountains greater than for years, assuring abundant water supply. Range feed plentiful and cattle in splendid condition. Winter wheat well advanced, though retarded in growth by snow covering in northern counties. Plowing for spring wheat and barley extensive in south-central counties, and some seeding done. Excessive rainfall interfered with mining and caused some damage to railways and dams. Oranges and lemons marketed. Large yields of garden truck in southern counties.—*L. N. Jesunofsky.*

**Arkansas.**—The temperature was considerably below normal, while the precipitation was slightly in excess. There was more than the usual amount of snowfall. Very little progress was made in farm work. Small grain did fairly well, but the acreage was small. Stock was healthy, but in poor condition, except where fed. Fruit sustained no material injury from low temperatures.—*Edward B. Richards.*

**California.**—The temperature was considerably above normal most of the month, but severe frosts occurred in some sections, with very little injury to crops. The rainfall was abundant in all sections and thoroughly saturated the soil. There was some damage to grain by the overflow of rivers in portions of the Sacramento Valley. On the whole, crop conditions were better than at last report, and far better than at this time last year.—*Alexander G. McAdie.*

**Colorado.**—Live stock remained in fair condition, notwithstanding the cold spells, except over areas in the western valleys, where the ranges were poor. Stock water was ample. Snowfall was about normal, except in the northwestern part of the State, where a deficiency was reported. On January 31 there was about one-third more snow than a year ago at high elevations on the upper drainage areas of the Grand and Gunnison, and double the amount of a year ago on the watershed of the Arkansas and South Platte, while for the Rio Grande there was a marked excess.—*F. H. Brandenburg.*

**Florida.**—With one exception, in 1893, the month was the coldest January since the Climate and Crop Service was established, and, except in 1886, it was the coldest January in Jacksonville since the establishment of a weather station in that city. In many sections the previous minimum temperatures were reached. The greatest damage befell vegetables. The tenderer kinds, such as beans and tomatoes, were killed where not protected; the hardier kinds, such as onions, cabbages, celery, English peas, turnips, and cauliflower, were damaged about one-half. Considerable unprotected fruit was frosted. Some young trees will die, but, as a whole, orange groves suffered only the loss of foliage. Pineapples on the mainland were severely damaged; those on near-by islands escaped serious consequences. The month was deficient in moisture.—*A. J. Mitchell.*

**Georgia.**—Month noted for sudden and decided changes in temperature; first few days springlike, rest of time temperature below normal; severe cold wave 25th and 26th, temperature near zero in northern section. Rainfall somewhat below normal, smallest average in the central section; light snowfall in northern half 29th and 30th. Cold weather prevented farm work, except in southern section, and injured grains, some late oats killed; outlook still good; seeding spring oats progressing. Fruit prospects unimpaired; trees in good condition.—*J. B. Marbury.*

**Idaho.**—The month was warmer than any previous January on record, except that of 1900, and there was a marked deficiency in precipitation. The snowfall in the mountains was unusually light and shortage of water was feared. Winter grain was in good condition. Fruit trees did well, except that some buds were swelling prematurely. Hay was abundant and stock was in good condition.—*Edward L. Wells.*

**Illinois.**—A sleet storm of unusual severity occurred on the 12th, the precipitation freezing into a covering of ice. It was difficult to determine the condition of wheat at the end of the month, a good portion of the crop being covered with ice and snow. Opinion, however, was freely expressed that probably considerable damage had ensued. The plant entered winter mostly in a weak state, due to adverse fall conditions, and had not attained sufficient vigor to withstand the rigors of severe weather.—*Wm. G. Burns.*

**Indiana.**—Three cold waves crossed the State during January and the mean temperature of the month was 4.9° below normal. Precipitation was also deficient, but was mostly in the form of snow, which furnished clover and fall sown crops partial protection during the extreme cold weather. Wheat on high ground was uncovered by winds and suffered in spots, but generally the crop, while not very promising, was in better condition at the end of January than at any previous time since it was sown.—*W. T. Blythe.*

**Iowa.**—This has been the coldest January experienced in Iowa since 1893. There were no general thaws to lessen the height of snow drifts, and the soil was well protected in all parts of the State. This was favorable for winter grain and grasses, though not so good for grazing cattle in the corn fields. As a whole the month was favorable for usual farm operations and feeding stock.—*John R. Sage.*

**Kansas.**—Wheat was well covered with snow after the 10th. It was in fine condition in the western counties, in good condition in the northern and central counties, and in favorable condition in the eastern counties, but was in poor condition in three southern counties. Corn was nearly all gathered. Cattle were doing well, and stockwater was increasing.—*T. B. Jennings.*

**Kentucky.**—Temperature below normal. Precipitation generally sufficient. Wheat and rye in better condition, but still showing some effects of fall drought. Some damage from cold where snowfall was light. Tobacco stripping made good progress, but color not up to expectation. Little delivered. Stock in fair condition. Fruit prospects favorable.—*F. J. Walz.*

**Louisiana.**—Weather conditions during the month were not favorable for agricultural operations. Low temperatures interfered with out-door work, and there was too much rain in some localities. Preparations for cotton, corn, and rice crops were not well advanced. Winter oats and rye suffered in some localities from freezing weather. Truck gardens and berries, where not protected, were injured by cold weather. Seed cane continued in very good condition, but planting was interfered with by wet, cold weather.—*I. M. Cline.*

**Maryland and Delaware.**—January temperatures averaged 3° below normal, with maximum of 69° on the 1st, and minimum of 14° below zero on the 31st. Precipitation was above normal, and snowfall was very heavy. The heavy snow of the 25th drifted badly, exposing fields and blocking roads. Little farm work was done. Wheat was somewhat damaged by alternate freezing and thawing; late wheat was more affected, because poorly rooted. Some tobacco was seeded. Grasses, fruit trees and stock wintered well.—*Oliver L. Fassig.*

**Michigan.**—Winter wheat and rye were well protected by a good snow blanket during practically the entire month of January. A few correspondents who carefully investigated wheat by digging through the snow reported that it had a vigorous and healthy appearance and seemed to be making a good winter growth. The snow was somewhat crusted on top, and the average depth on the 15th and 31st of the month was about five inches.—*C. F. Schneider.*

**Minnesota.**—There were cold periods from the 8th to the 16th, and from the 22d to the end of the month. The monthly mean minimum temperature at every station except Worthington was below zero. The maximums occurred for the most part on the 1st. The precipitation was all snow and the amount was slightly above the normal. The State was covered with snow all the month. A splendid ice crop was being gathered all the month.—*T. S. Outram.*

**Mississippi.**—The month was unusually cold, with considerable freezing weather. The soil was frozen to the coast line on the 26th. Rains were frequent and general, but excessive in only a few localities. Light snow occurred in the northern counties. Very little farm work was done during the month, owing to the unfavorable conditions. Oats were injured by the freeze on the 26th.—*W. S. Belden.*

**Missouri.**—Winter wheat was well protected by snow during the greater part of the month, and, while the actual condition was unknown at the close of the month, the consensus of opinion was that the crop had not deteriorated. The cribbing of corn was practically completed. The grain was in good condition and graded well. Some injury to fruit buds by severe cold.—*George Reeder.*

**Montana.**—January was unusually mild, except during two brief periods, when temperatures below zero occurred in all sections. Light snows occurred at frequent intervals, furnishing water for stock; the ranges, however, were clear of snow the greater portion of the month. There were no storms injurious to stock. Cattle and sheep were in good condition throughout the month and the ranges in most sections afforded all the feed necessary.—*R. F. Young.*

**Nebraska.**—The ground was well covered with snow after the 10th, furnishing effective protection to the wheat from the low temperatures of the month. This made the prospects for wheat rather better than at

the end of December. Practically no farm work was done. All stock continued in good condition.—*G. A. Loveland.*

**Nevada.**—The weather of the month was remarkably dry and unusually mild. Range stock did well throughout the month. The snow conditions at the close of the month were generally satisfactory, and a good flow of water seemed assured for the coming season.—*J. H. Smith.*

**New England.**—The weather of the month was colder than usual, and the temperature was continuously low, there having been no "January thaw." Several severe storms passed over the district, the most notable of which were on the 3d-4th, 6-7th, and 24-25th. The weather conditions were favorable to the lumbering interests and to ice harvesting. The covering of snow on the ground throughout the month was favorable to grass and winter grain and to bulbs and roots in the ground.—*J. W. Smith.*

**New Jersey.**—At the close of the month a blanket of snow from twelve to twenty inches in depth covered the ground. Wheat, rye, and grass continued in good condition, except in portions of the southern section, where alternate freezing and thawing did some injury. Fruit trees continued dormant.—*Edward W. McGann.*

**New Mexico.**—Mild, wet month, especially first half. Soil well moistened and in excellent condition for early plowing, seeding, range, and abundance of water. Alfalfa and fruits apparently wintering well. Range poor in northeast counties, and some loss of cattle and sheep, but, generally, stock in fair to good condition and farmers and ranchmen confident of very favorable coming season. Mountains heavily laden with snow, but valleys and southern slopes generally bare at close of month.—*Charles E. Linney.*

**New York.**—The month was moderately cold, with little heavy snowfall, except in the southeast portion. Winter grains and grass were generally well protected by snow and in good condition, except in sections of the central and eastern portions of the State. Fruit buds were uninjured by freezing. Live stock was wintering well and seemed to be in good condition. The ice harvest was about completed.—*H. B. Hersey.*

**North Carolina.**—The month was quite unfavorable for farm work and the growth of crops on account of the continuous cold weather. Farming operations ceased entirely. The severe freeze of the 25th to 27th killed much late seeded winter wheat and oats that were just up, and at the close of the month the condition of both crops was poor, with little evidence of growth. Early sown crimson clover did well, late sown was poor. There was slight damage to truck crops under glass.—*C. F. von Hermann.*

**North Dakota.**—The month was generally favorable for live stock, especially on the ranges in the western part of the State. In that section the snow on the ground was not deep enough to prevent grazing on the prairies, while it afforded ample moisture to satisfy thirst.—*B. H. Bronson.*

**Ohio.**—The month was cold and dry. Wheat was benefited by the precipitation near the last of December. It was well protected by snow over most of the State during the coldest weather in January. There was but little corn remaining in the field at the end of the month. Rye was in good condition. The weather was favorable for the stripping and handling of tobacco. Fruit buds were in good condition.—*J. Warren Smith.*

**Oklahoma and Indian Territories.**—Cold waves of 10th and 24th caused marked departures from daily average temperature and made the month the coldest January on record. Precipitation was above average and, occurring in form of sleet and snow, materially benefited wheat and placed ground in fine condition for plowing and seeding. Stock in good condition, but suffered somewhat during cold periods. Fruit trees in good condition.—*C. M. Strong.*

**Oregon.**—No cold spells sufficiently severe to harm fall grain occurred, and at the close of the month fall wheat, fall oats, alfalfa, clover, vetch, and cheat were in excellent condition. Pasture was as good as usual at this season of the year, and stock in many sections was able to obtain a living without being fed hay. Fruit trees continued in fine condition.—*Edward A. Beals.*

**Pennsylvania.**—With the exception of 1904, this was the coldest January since 1893. The average precipitation was the heaviest since 1898 and was very unevenly distributed. The snowfall was materially above the normal. Winter grain was generally well protected and was thought to be uninjured, except in the southeast section, where high winds during the latter part of the month exposed many fields and covered others with heavy drifts which may prove damaging.—*T. F. Townsend.*

**Porto Rico.**—Rainfall fairly well distributed and generally sufficient. Cane harvesting continued in the southern division; grade of juice better than during same period last year. Grinding began in northern and eastern divisions; grade of juice low. Young canes doing well generally. An unusually large amount of land being prepared for the next cane crop. Cotton yielding well in most districts; picking and planting in progress. Coffee trees blossoming abundantly. Small crops generally in good condition but not very abundant in markets. Oranges plentiful and of good quality.—*E. C. Thompson.*

**South Carolina.**—January had one cold wave that damaged oats and truck severely, but did no injury to wheat or to fruits. Some plowing was accomplished. Some oats were sown over the eastern and central counties, but none in the western ones. Less than the usual amount of

## SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS, JANUARY, 1905.

In the following table are given, for the various sections of the Climate and Crop Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and

lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.						Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.				Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.			Station.	Amount.	Station.	Amount.
Alabama.....	39.0	- 5.7	Daphne, Lucy.....	77	11	Valley Head.....	1	25	Uniontown.....	7.70	Bridgeport.....	2.20
Arizona.....	47.3	+ 2.6	Bowie.....	93	4	Fort Defiance.....	- 5	13	Pinal Ranch.....	9.00	Mohawk Summit.....	0.10
Arkansas.....	33.3	+ 6.5	Amity.....	73	1, 20	Pond.....	-13	15	Lake Village.....	8.89	Bodd City.....	1.32
California.....	48.3	+ 2.9	Riverside.....	87	29	Gunnison.....	-16	1	Upper Mattole.....	23.56	Bodie.....	0.10
Colorado.....	23.7	- 0.2	Cheyenne Wells.....	69	2	Middleburg.....	-30	12	Santa Clara.....	3.21	Wray.....	0.04
Florida.....	52.9	- 4.4	New Smyrna.....	85	12	Diamond.....	1	25	De Funiak Springs.....	7.28	2 stations.....	T.
Georgia.....	40.8	- 4.4	St. Marys.....	78	2	Chesterfield.....	-18	10	Clayton.....	7.91	Waverly.....	1.17
Idaho.....	28.5	- 5.3	Blue Lakes.....	61	26	Lanark.....	-15	25	Lovell.....	8.73	Lost River.....	T.
Illinois.....	20.5	- 5.3	Cisne.....	67	1	Northfield.....	-16	10	Raum.....	3.71	Dixon.....	0.32
Indiana.....	23.1	- 4.9	Mount Vernon.....	74	1	Inwood.....	-30	25	Marengo.....	4.40	Northfield.....	1.21
Iowa.....	11.2	- 7.0	Keokuk.....	56	1	Republic.....	- 30	15	Lacona.....	1.82	Storm Lake.....	0.12
Kansas.....	21.8	- 8.2	(Emporia.....	67	1)	Farmers.....	-15	26	Toronto.....	2.45	Wallace.....	0.27
Kentucky.....	27.5	- 6.4	Cunningham.....	67	3	(Amite.....	-13	16)	Mount Sterling.....	4.31	Anchorage.....	1.02
Louisiana.....	45.5	- 4.7	Jetmore.....	67	4)	Calhoun, Ruston.....	-13	26	Covington.....	8.40	Robeline.....	2.75
Maryland and Delaware.....	28.6	- 2.9	Jackson.....	70	1	(Plain Dealing.....	-13	26)	Baltimore, Md., (J. J. H. Hospital.).....	4.72	Boetcherville, Md.....	1.67
Michigan.....	16.4	- 3.9	Leesville.....	82	20	(Grantsville, Md.....	-14	29)	Eagle Harbor.....	3.73	Sault Ste Marie.....	0.64
Minnesota.....	5.6	- 5.5	Hancock, Md.....	69	1	(Oakland, Md.....	-14	31)	Luverne.....	1.60	Red Wing, No. 1.....	0.04
Mississippi.....	40.0	- 5.9	Grape.....	52	1	Humboldt.....	-28	3	Hazlehurst.....	8.95	Biloxi.....	4.14
Missouri.....	22.3	- 7.5	(Glencoe, Milaca.....	50	1)	Pokeyama Falls.....	-52	10	Willow Springs.....	4.28	Steffenville.....	0.17
Montana.....	18.1	- 1.3	(New Ulm.....	50	1)	(Corinth.....	5	26)	Columbia Falls.....	2.14	Twin Bridges.....	0.01
Nebraska.....	17.1	- 5.7	Poplarville.....	77	10	(Holly Springs.....	5	25, 26)	Fullerton.....	2.30	Grant.....	0.17
Nevada.....	34.5	+ 6.8	Vichy.....	72	1	(Oregon.....	-19	25)	Eureka.....	2.60	Hawthorne.....	0.00
New England*.....	18.3	- 3.3	Cascade, Livingston.....	56	25	(Warsaw.....	-19	15)	Durham, N. H.....	7.60	Cornwall, Vt.....	0.96
New Jersey.....	27.0	- 3.0	Callaway.....	65	1	Glendive.....	-45	31	Charlotteburg.....	7.13	Trenton.....	2.68
New Mexico.....	35.2	+ 1.1	Wadsworth.....	72	29	(Agate, Bridgeport.....	-35	13	Clouderoft.....	3.20	Cimarron.....	0.26
New York.....	18.2	- 3.9	Framingham, Mass.....	56	1	Potts.....	-11	12	Boys Corners.....	6.54	Ogdenburg.....	1.14
North Carolina.....	36.3	- 3.9	Bridgeton, Friesburg.....	60	1	Van Buren, Me.....	-45	15	Horse Cove.....	6.53	Kinston.....	0.85
North Dakota.....	0.9	- 5.3	Carlsbad.....	80	23	Layton.....	-16	31	Walhalla.....	0.80	4 stations.....	T.
Ohio.....	22.7	- 5.2	Elmira, Waverly.....	56	1	Springer.....	-16	13	Walhalla.....	0.80	4 stations.....	T.
Oklahoma and Indian Territories.....	30.0	- 7.8	Whiteville.....	76	12	Paul Smiths.....	-29	31	South Lorain.....	2.91	Colebrook.....	0.57
Oregon.....	36.3	+ 1.7	(Ellendale.....	48	2)	Linville.....	- 8	25	Blackburn, Okla.....	5.66	Cleo, Okla.....	0.50
Pennsylvania.....	23.8	- 3.2	(Sentinel Butte.....	48	3)	Walhalla.....	-40	10	Gold Beach.....	12.87	Joseph.....	0.18
Porto Rico.....	73.6	- 4.8	Lancaster.....	65	1	Greenhill.....	-17	29	Gordon.....	7.55	Elwood Junction.....	1.72
South Carolina.....	41.4	- 4.8	(Pauls Valley, Ind. T.....	72	1)	(Kenton, Okla.....	-20	13)	Cidra.....	17.40	Juana Diaz.....	T.
South Dakota.....	9.1	- 5.8	(Ravia, Ind. T.....	72	1)	(Gage, Okla.....	-20	15)	Walhalla.....	4.83	St. George.....	0.30
Tennessee.....	31.5	- 6.7	Williams.....	72	23	Pine.....	-10	11	Spearfish.....	1.62	Herried.....	0.03
Texas.....	28.9	+ 2.7	Claysville.....	69	1	Smethport.....	-21	30	Santa Fe.....	5.71	Dyersburg.....	1.92
Utah.....	31.5	- 3.5	Juana Diaz.....	33	4	Aibonito.....	49	3 dates	Beaumont.....	6.94	2 stations.....	0.00
Virginia.....	31.5	- 3.5	Walterboro.....	77	1, 12	Greenville.....	8	26	Ranch.....	3.15	Callao.....	0.05
Washington.....	34.0	+ 1.8	Fairfax.....	62	2	Ramsey.....	-37	25	Spottsville.....	4.07	McDowell.....	0.72
West Virginia.....	26.4	- 5.0	Dover.....	75	1	Rugby.....	-7	25	Union City.....	14.26	Zindel.....	0.48
Wisconsin.....	8.4	- 6.8	Fort Ringgold.....	91	11	Texline.....	-15	15	Terra Alta.....	7.43	New Cumberland.....	1.48
Wyoming.....	21.1	- 0.2	Fillmore.....	71	25	Fort Duchesne.....	-22	13	Sheboygan.....	3.75	Berlin.....	0.06
			Saxe.....	70	1	McDowell.....	-15	15	Centennial.....	2.80	Thermopolis.....	0.05
			Zindel.....	64	28	Twisp.....	-16	11				
			Doane.....	70	2	(Buckhannon, Weston.....	-14	4)				
			Prentice.....	52	1	(Cario.....	-14	29)				
			(Hyattville.....	60	25, 26)	Hayward.....	-36	10				
			(Marquette.....	60	25)	Lusk.....	-33	12				

commercial fertilizers was hauled. The rainfall was copious in the western counties, but deficient in all other parts.—*J. W. Bauer.*

**South Dakota.**—There was considerable cold weather in the second and third decades, but live stock withstood the low temperature and was generally in good condition and wintering well. The snow on the open ranges was not sufficient to interfere materially with grazing, but enabled stock to satisfy thirst conveniently and thereby permitted ranging at considerable distances from usual watering places. Winter rye and the limited acreage of winter wheat were generally protected by snow.—*S. W. Glenn.*

**Tennessee.**—The month was very cold, with precipitation decidedly below the normal. Hard freezes occurred from the 14th to 17th and 24th to 27th. There was but little snow until the 29th, when heavy amounts fell. Grains were unprotected in the coldest weather. Early sown wheat and winter oats and rye were in fair condition, but late sown wheat looked weak and seared. Pastures were poor.—*H. C. Bate.*

**Texas.**—There was generally a deficiency of precipitation over the State, and in some counties the deficiency was very marked; in a few eastern counties, however, there was an excess. Several cold waves occurred during the month. Freezing temperatures occurred to the coast, and below zero in the northwest. Reasonably good progress was

made with preparations for putting in new crops. The cold weather damaged growing crops somewhat, but damage was lessened by snow in the north. Drought caused some damage also. The general condition of winter grain, gardens, pastures, and stock was fair to good at the end of the month.—*M. E. Blystone.*

**Utah.**—Abnormally warm weather prevailed, with a great deal of cloudiness. Warm winds swept the snows from the valleys and dried the soil, making possible the plowing of a considerable acreage. Winter grain and the range became green under the springlike weather, and wheat was somewhat revived. The range furnished ample feed for stock.—*R. J. Hyatt.*

**Virginia.**—The weather of the month was variable, moderate temperatures occurring in the first decade and some hard freezes in the second and third decades. Precipitation was below normal. Fall sown grains, as wheat and oats, also clover and grasses, were insufficiently protected by snow during the month, and some local winter killing occurred. Barley and rye did fairly well. Considerable ice formed, and farmers generally completed ice harvest.—*Edward A. Evans.*

**Washington.**—The month was mild, with abundant rainfall west of the Cascade Mountains and sufficient snow and rain in the wheat section of the eastern counties. The snow covering over the wheat lasted from

the 12th to the 25th, when removed by rain and warm spell. The moisture soaked in, improving the soil. Early fall sown wheat was in thrifty condition, but the late sown was retarded by dry soil and lack of rain and was not so vigorous.—*G. N. Salisbury.*

*West Virginia.*—The weather was generally quite cold during the month, and there was considerable snowfall. Wheat and rye were generally well protected, but the prospects were poor. Stock was wintering well, with prospect of sufficient feed. No plowing was done.—*E. C. Vose.*

*Wisconsin.*—The month as a whole was decidedly cold, the average temperature for the State being but  $0.3^{\circ}$  above the average for January, 1904, which ranks among the coldest Januaries during the past thirty-four

years. The snowfall for the State averaged about thirteen inches and was fairly well distributed. Winter grains and grasses were thoroughly protected during the month by an ample covering of snow.—*W. M. Wilson.*

*Wyoming.*—A cold wave overspread the State on the 11th, 12th, and 13th, but as it was not accompanied by much snow, stock did not suffer any injury. Another storm and cold wave was quite general over the southern half of the State at the close of the month, and some apprehension was felt in regard to stock. As a whole, the month was favorable for stock, which remained in good condition, with practically no losses reported.—*W. S. Palmer.*

## SPECIAL ARTICLES.

### ESCAPE OF GASES FROM THE ATMOSPHERE.

By DR. G. JOHNSTONE STONEY, F. R. S.

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A letter under the above heading by Mr. S. R. Cook, in Nature of the 24th of March, 1904,<sup>1</sup> puts forward views that ought not to remain on record without reply; and as between thirty and forty years ago I carried on the investigation into the rate at which gases can escape from atmospheres in the same way as Mr. Cook has done, and arrived, from the premises employed by him, at substantially the same conclusions, perhaps the best answer will be to state the considerations which led me to distrust that line of argument and finally to abandon it. To do this, however, requires more to be said than can be brought within the compass of a letter to a weekly journal; and on this account, and because the discussion is a physical discussion and concerns one of nature's greater operations, I venture to request for the following pages the hospitality of the Philosophical Magazine.

A study of the phenomena attending the escape of gases from atmospheres has been approached in two ways—*inductively*,<sup>2</sup> by arguing upward from events that are found to have occurred or to be in process of occurring in nature; and *deductively*,<sup>3</sup> by drawing inferences from the supposition that it is legitimate to attribute to the real gases of nature behavior which it has been ascertained would prevail in certain models of gas, so much simpler in their constitution than real gases that the progress of events within them is susceptible of mathematical treatment.

The two methods, as hitherto employed, have led to contradictory results, of which one, at least, must be erroneous. Mr. Cook, who has of recent years employed the deductive method, expresses the opinion in his letter that the numerical results which have been arrived at by this method "will have to stand" until they can be disproved "by other *a priori* reasoning".

Serious students of nature must, I think, hold that man, in his dealings with nature, is not in position to limit in this way the kind of proof he will accept, and that it is sufficient if in any way Mr. Cook's inferences from Maxwell's researches can be disproved, whether by valid *a priori* or by valid *a posteriori* reasoning. And, moreover, that when once they are disproved we are brought face to face with the fact that there has been a mistake somewhere in the data which have led those who trusted in them to a false conclusion.

<sup>1</sup> In the Monthly Weather Review for August, 1902, p. 401, we also have published a very suggestive paper on the above subject by S. R. Cook. But it deals with problems on the very boundary of the present state of our knowledge, and when learned authorities differ we must in all honesty present both sides of the case to our readers. We accordingly reprint Doctor Stoney's conservative conclusions, as showing the need of further investigation before the subject can be considered definitely settled.—*C. A.*

<sup>2</sup> "Of atmospheres upon planets and satellites." By G. Johnstone Stoney, F. R. S. See Scientific Transactions of the Royal Dublin Society, vol. 6, p. 305, October, 1897; or Astrophysical Journal, January, 1898, vol. 7, p. 25.

<sup>3</sup> "On the escape of gases from planetary atmospheres according to the kinetic theory." By S. R. Cook. See Astrophysical Journal, January, 1900, vol. 11, No. 1.

What convinced me several decades ago that the conclusion at which I arrived and at which Mr. Cook has arrived is false, is that it represents the moon as incompetent to get rid of the atmosphere which it originally shared with the earth, and of the gases which it has since evolved in abundance from its own interior. We knew thirty-five years ago, as we know now, that any reasoning which makes out that the moon has retained its atmosphere must have a flaw in it somewhere. Furthermore, since that time other facts not then known have come to light and in a marked degree confirm the judgment which was then formed. Our confidence that we are on the right track is justifiably strengthened when, as in this case, further discoveries as they emerge confirm the view to which we had been led when our materials were more scanty. The presence of helium on the earth was not then known, and the argument<sup>4</sup> which has been based on what is now known of its behavior may be summarized as follows: helium is supplied to the earth's atmosphere through certain hot springs, and under circumstances which indicate that it also oozes up through the soil. It is, however, what is carried up by the water of these springs that can be subjected to experimental examination. The other gases of our atmosphere, such as nitrogen, oxygen, and argon are found to accompany the helium in these springs, but with this marked difference, that whereas the other gases are present in such proportions as are consistent with their merely being portions of those gases which are being returned to the atmosphere after having been washed down into the earth from the atmosphere by rain, the case is entirely different when we come to helium. The quantity of helium passed into the atmosphere through those springs is found to be from 3000 to 6000 times more than can be accounted for as a return to the atmosphere of helium which had been washed down out of it. Accordingly we are justified in regarding this great surplus of helium as being an addition which is being uninterruptedly made to the atmosphere. Notwithstanding this, the quantity of helium in the atmosphere has not gone on increasing. The earth at the present rate of supply furnished in a small number of years a quantity of helium equal to the quantity which the atmosphere can at present retain, i. e., in a number of years which is exceedingly small from a geological standpoint, which is the point of view that is here appropriate. The inference from these facts is the obvious one, that helium is by some agency being eliminated from our atmosphere as fast as it is being introduced into the atmosphere from the earth. Two possible agencies for the elimination of the helium suggest themselves, chemical reactions and an escape of helium from the upper part of the atmosphere. Of these, chemical agency is excluded by the extreme chemical inertness of helium. What remains then is that there is an outflow of helium from the top of the atmosphere equal to the inflow at the bottom, and that the trace of helium that is at any one time present in the atmosphere is helium part of which is slowly making its way upward to the

<sup>4</sup> The argument here summarized is based on the marvelous determinations made by Sir William Ramsey, K. C. B., F. R. S., or in his laboratory, and will be found with the necessary details in a paper on the behavior of helium in the earth's atmosphere. By G. Johnstone Stoney, Astrophysical Journal, vol. 11, p. 369, 1900.